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Implementation of Material Control and Accounting at the Nuclear Facilities in Kazakhstan

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INTRODUCTION:

The Republic of Kazakhstan has four nuclear facilities, all of which are involved in the US/Kazakhstan Cooperative Threat Reduction Program. This talk focuses on the material control and accounting (MC&A) activities at three: Ulba Metallurgical Plant and the two locations of the Institute of Atomic Energy (Kurchatov and Almaty). Two of these facilities are primarily research reactors with limited quantities of bulk material. The third, Ulba Metallurgical Plant, is one of the world's largest low-enriched uranium fuel fabrication facilities. With the signing of the Nonproliferation Treaty in 1993, Kazakhstan pledged full implementation of safeguards on all nuclear materials and has aggressively pursued this goal over the past several years.

The US teams have worked with the technical staff at each of these facilities to develop comprehensive MC&A systems that support accurate and timely reporting to the national authorities based on measured values. The goals have been to meet national and international requirements for safeguards. During CY98 the program has focused on completion of projects and development of long-term support for the comprehensive MC&A systems. The success of these systems represents years of concerted effort by the technical staff at these facilities.

INSTITUTE OF ATOMIC ENERGY, ALMATY (IAE-A)

The Institute of Atomic Energy-Almaty is a branch of the Kazakhstan National Nuclear Center (NNC). It is located in the town of Alatau, approximately 16 kilometers south of Almaty, the former capital of Kazakhstan. The IAE-A possesses and operates a VVR-K research reactor, which was restarted in April 1997 after being inactive since 1988 due to seismic concerns. The VVR-K is a ten megawatt water-cooled and moderated reactor. The NNC plans to use the reactor commercially, to manufacture radioisotopes (Te-99), as a radiation source for industrial and medical use (including the sterilization of medical equipment using spent reactor fuel), for related gamma radiation technology development, and to conduct neutron activation analysis. Nuclear material at the IAE-A (fresh and spent reactor fuel and other nuclear material in bulk form) is located in the VVR-K reactor building. All nuclear material in the VVR-K building is stored in nuclear material storage vaults.

The primary focus of the material control and accounting activities has been on upgrading the accounting system, the facility's capability to measure mass and uranium isotopic enrichments, and the facility MC&A procedures.

The initial activity was to facilitate the confirmation of the initial declaration of nuclear materials by providing electronic scales with the capacity to measure the containers of bulk materials. Previously, the facility had been required to divide containers and measure the materials in portions due to the limited capacity of the measurement systems. In addition, a gamma spectroscopy system was provided to permit confirmation of measured values for uranium enrichment.

The US provided computers which permitted data accumulation and automated generation of inventory lists and reports. The facility has been provided with the Automated Inventory Accounting System (AIMAS) software which is being customized to match the facility operations.

As part of the overall Department of Energy (DOE) enhancement program, the facility has developed procedures and worked with the US team on the development of a comprehensive MC&A plan.

INSTITUTE OF ATOMIC ENERGY AT KURCHATOV (IAE-K)

The Institute of Atomic Energy at Kurchatov is a branch of the Kazakhstan National Nuclear Center (NNC). It is located near the town of Semipalatinsk, on the Semipalatinsk testing site. The testing activities were halted several years ago. There are two sites with research reactors. **The IGR research reactor is a graphite reactor used to test nuclear fuel and to simulate activities occurring within power reactors, including loss of coolant or runaway excursions. The IAE-K is actively working to negotiate contracts for work for the IGR reactor. There are two thermal research reactors at the Baikal-1 site. The Baikal-1 complex was created for the experimental testing of the reactor prototypes for nuclear rocket engines.**

Nuclear material at the IAE-K (fresh and spent reactor fuel and other nuclear material) is located at both the IGR and Baikal-1 facilities. **The IAE-K delayed implementation of full-scope International Atomic Energy Agency (IAEA) safeguards until October 1996 due to the presence of nuclear materials owned by the Russian Federation. During the past 2 years, these nuclear materials have been packaged and shipped back to the Russian Federation.**

The US provided AIMAS software for evaluation and the facility software engineers have worked with the MC&A Manager to customize the code to meet the facility specific requirements. The initial focus was to facilitate electronic reporting to the Kazakhstan Atomic Energy Agency and to support IAEA requests for information during ad hoc inspections. The second phase of the customization addresses the internal transfers of materials and modifying

the code to match the material flows and activities within and between the two reactor sites.

As a small research reactor with limited staff assigned to the implementation of safeguards, one of the positive factors has been the close working relationship between the MC&A Manager and the Technical Manager for the Physical Protection Upgrades. These two individuals share an office and work together which greatly facilitates the integration of the two systems.

Due to the limited number of transactions and staff, the MC&A Manager has written a single comprehensive procedure for MC&A activities. This single procedure outlines the specific activities required by operations staff and acts essentially as an MC&A plan in that it provides a clear picture of the overall MC&A program. As in small US facilities, the need to concentrate MC&A functions in one person makes the separation of key MC&A duties an impossibility but the IAE-K system provides checks through the assignment of custody of the nuclear materials to the reactor operations staff. In addition, while the materials accounting activities are captured in an automated system, the system requires paper documentation for actual physical movements of materials with approvals from multiple departments outside MC&A.

ULBA METALLURGICAL PLANT (Ulba)

The Ulba Metallurgical Plant is a large low-enriched uranium fuel pellet fabrication facility located in northeast Kazakhstan in the city of Ust-Kamenogorsk. It used to produce the pellets used in half of the fuel fabricated for Soviet reactors. In recent years the production of fuel pellets has been somewhat reduced and the facility has also been converting uranium hexafluoride to powder and shipping the powder to western fuel fabrication facilities.

Implementation of full-scope safeguards at the Ulba Metallurgical Plant (ULBA) presented significant challenges for the MC&A technical staff including:
1. The need to develop a detailed listing of the large quantities of materials on-site in inventory,
2. The wide distribution of processing functions in multiple buildings at the facility with large throughput of nuclear materials, and
3. The need to improve the measurement capabilities.

The joint US-ULBA team developed a prioritized list and worked on multiple areas in parallel to minimize the time required for implementation of a comprehensive MC&A system. The overall focus of the plan was to permit drawing a material balance around the facility then to work on tracking and accounting for internal activities. The initial equipment delivery was computers to permit the start of the automated accounting system that was crucial for accurate reporting to the national and international authorities. Then the equipment needs related to enhancement of the measurement capabilities were addressed including:
1. Scales (analytical balances, mass comparators, production scales, and large scales to measure shipments and receipts),
2. Nondestructive assay systems (portable gamma spectroscopy systems) to provide the ability to confirm measured values, measure wastes, and work on measuring uranium in hold-up in the process piping, equipment and ventilation ducts (documented in separate paper on hold-up measurements)

3. Analytical Chemistry equipment:
   3.1. Mass spectrometer, this was the highest priority for the facility due to the age of the existing equipment and the need to precisely measure enrichment
   3.2. Automated titrators to improve the accuracy of the measurement by reducing the need to visually determine the endpoint during the titration process

In each case, vendor training was obtained for the use and maintenance of the equipment as well as training provided by US technical specialists. In this area, there are opportunities to enhance the effectiveness of the equipment through additional training that has been requested for FY99 as part of the on-going support program.

The Physical Inventory Program has been driven primarily by the need to meet the International Atomic Energy Agency (IAEA) requirements. The first physical inventory was completed during the fall of 1994 and the scope of the difficulties were defined. The facility had extensive materials in essentially static storage and the verification of the accuracy of the book values for these materials presented a challenge. This exercise drove the initial focus to be on automating the materials accounting process. The initial data base was simply a data accumulation tool based on input of the physical inventory data to permit the development of the formal declaration of the nuclear materials. The US-provided COREMAS code was selected as the accounting system and training related to the system design and software tools was provided. The Ulba Information Management Department initiated work on the overall program but also developed short-term solutions based on modifications of the reporting system code provided by Sweden. The transition from a totally manual system to an automated system has been accomplished over a period of 3 years with the result that the MC&A and operating area staff have had time to get used to the new methods of operation. In addition, the facility has experimented with automated data collection using bar codes. One of the more successful experiments has been the application in the storage building which uses bar codes and an Ulba-developed interface which shows the storage configuration and permits the operator to query each position to identify specific items or to search for the location of a specific item of nuclear material. This database has significantly reduced the time required for the facility to locate the specific items required for measurement during IAEA physical inventory verifications.

During the summer of 1995 the facility completed the first full inventory and after the 1996 inventory was able to calculate an inventory difference. It was during the evaluation of this inventory difference that the significance of the absence of an effective measurement control program was fully understood by Ulba management. In the absence of a comprehensive measurement control program the IAEA assumes a measurement error matching the IAEA target values and also assumes that there is no random error based on the assumption that all items are measured. This reinforced the MC&A team (US and Ulba) position on the need to implement a measurement control program.

Since a key component of an effective measurement control program is the routine use of standards, considerable effort has been expended both to obtain standards and to discuss ways to incorporate the routine use of standards as a basis for calculating the estimate of error of systems used for determining accountability values for materials. The US provided certified weights for the Metrology Department and supported the manufacture of 500-kilogram check weights for the large (1.5, 3 and 6 metric ton) scales. These weights have been certified in Kazakhstan and are very high quality. The design and manufacture of the weights shows a commitment to quality work and an understanding of the crucial need for precision standards as part of the measurement system. Ulba MC&A staff have developed the overall Measurement Control program and are working to develop the implementing procedures and training for operating staff.

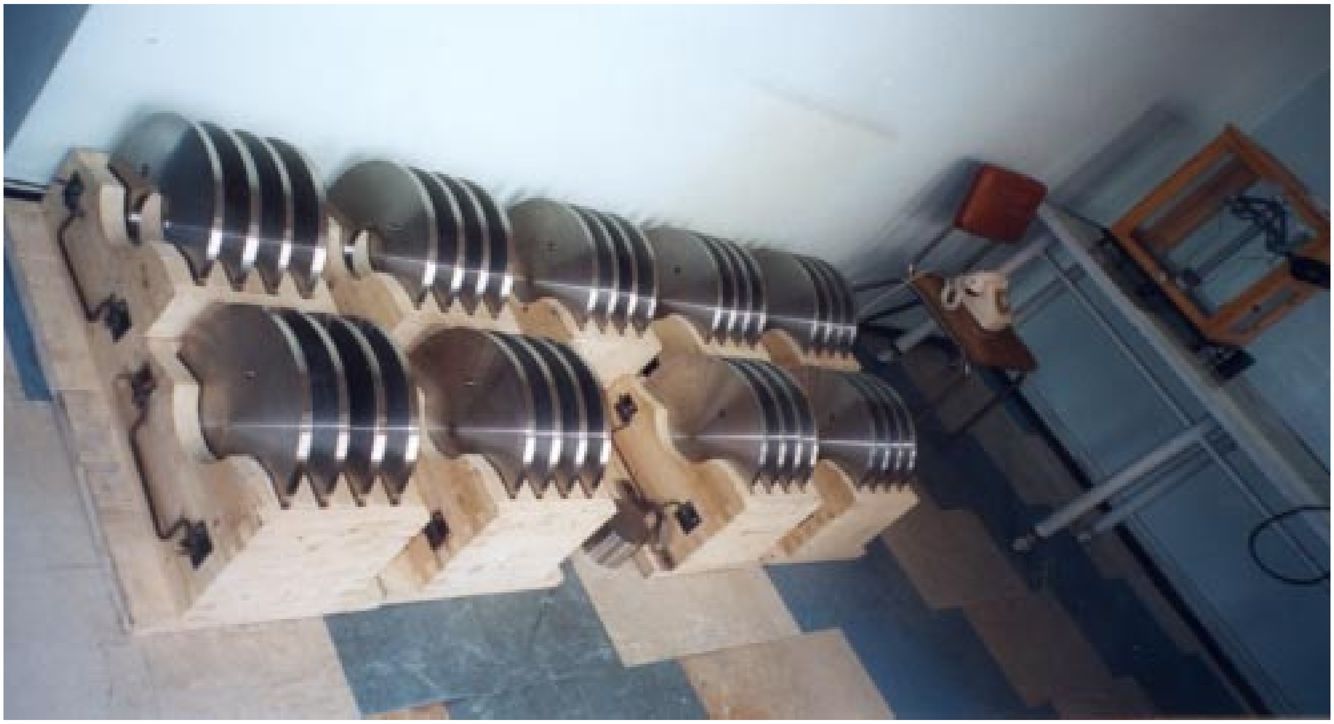

Photo of manufactured 500 kilogram weight

The DOE is optimistic that a similar approach can be used for uranium enrichment standards. DOE is working with the Kazakhstan Atomic Energy Agency to resolve export/import issues to permit the shipment of one set of internationally recognized standards comprising 8 different enrichments. Using these reference standards, the facility can then manufacture additional sets for use within the plant.

<u>PROJECTED ACTIVITIES FOR FY99</u>

Institute of Atomic Energy at Almaty

1. Finalize AIMAS software customization.
2. Training on gamma spectroscopy equipment.
3. Technical support for implementation of MC&A program, follow-up work to address questions during implementation including support for facility developed MC&A training programs.

Institute of Atomic Energy at Kurchatov

1. Finalize AIMAS software customization.

2. Training on use of an Active Well Coincidence Counter and follow-up training for an InSpector gamma spectroscopy system.
3. Technical support for implementation of MC&A Program, follow-up work to address questions during implementation including support for facility developed MC&A training programs.

Ulba Metallurgical Plant

1. Technical support for hold-up measurement system and waste measurements
2. Joint technical work to improve the NDA enrichment measurements
3. Technical support for the implementation of the measurement control program
4. Additional support for the material tracking system and the expansion of the accounting system to provide near real-time accountability of materials within the material balance areas
5. Technical support for the facility developed MC&A training programs.

LESSONS LEARNED

During the past almost 4 years as the technical teams from the US and Kazakhstan have been working to develop MC&A systems at these facilities several fundamental principles have emerged:

1. A key factor in the success of the overall MC&A program is the assumption of ownership the program by at least one facility manager who acts as an advocate for the program.
2. Frequent, focused visits by US small technical teams sped the process by assisting the local advocate maintain management commitment and encouraging the facility technical staff.
3. Development of local sources for equipment parts reduces the time and cost of these parts and also aids in the transition from a fully supported system to a more limited support program.
4. Periodic inspections of the US provided equipment assists the MC&A staff in maintaining ownership of the equipment as well as providing a basis for discussion with the technicians using the equipment.
5. The equipment selection process used in Kazakhstan of documenting agreement between the facility and the US technical team before placement of orders helps to ensure the equipment meets the needs of the facility, and subsequently is appropriated used after delivery.
6. The use of informal lectures by technical specialists whenever possible assists in increasing the understanding of the maximum number of facility specialists in the overall MC&A program activities. For example, 42 specialists attended a lecture on measurement control at Ulba. These lectures assisted the facility MC&A staff by providing confirmation of the technical program developed by the local staff.
7. Both sides need to remember that while the MC&A theory is simple and straightforward, there can be significant problems during implementation and these are problems that must ultimately be solved by the facility technical staff.